PHASE
MOTION CONTROL

TW

MOTORS WITH INTEGRATED SERVODRIVE

User Manual

Conformities

Declaration of Conformity
For PMC components there are declarations of conformity available. These declarations confirm that the components are designed according to valid EC directives. If required, you can ask your sales representative for these declarations.

Low-Voltage Directive
The PMC products of a drive system mentioned in this documentation comply with the requirements of the EC Directive (see page 39).

EMC Directive
The PMC products of a drive system mentioned in this documentation comply with the requirements of the EC Directive (see page 39).

CE Label

Safety Instruction

Please read before the initial startup. See page 49.

PHASE
MOTION CONTROL

TW

MOTORS WITH INTEGRATED SERVODRIVE

User Manual

Supported Models

TW03A02.50.4

TW05A03.40.3
TW05A06.30.3
TW05A09.20.3

TW0720.40.4
TW0730.30.4
TW0740.20.4

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MARY

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1

INTRODUCTION: TORQUEWIRE MOTORS

Phase Motion Control
TW Motors with Integrated Servodrive

The new TorqueWire series of integral servo systems sets a new style in complex automatic machinery architecture. TorqueWire motors are complete, self sufficient servo axis building blocks which allow the design, integration and operation of large multi axis systems with minimum hardware and surprising ease. The TorqueWire motor system consists of an advanced, high performance rare earth brushless servo motor, a DSP based, high voltage interpolating servo drive and a single or multi turn absolute encoder, all assembled in a very compact IP 67 protected frame.
The motor systems are controlled via a multi drop CANOpen field bus (or EtherCAT filed bus), linking together groups of motors on a single bus system. The motors are supplied from a common DC bus and braking energy from any drive is intrinsically recycled on any other axis on the network. The performance of TorqueWire originates in the advanced design of both motor and drives.
The motor parts take advantage of a novel, patent pending winding design, along with new magnetic materials and a special winding technique, all of which result in a servo motor with about 60% of the size of a conventional servo design. Such advantage is invested in both temperature rise derating and space for the drive, so that TorqueWire motors, including the drive, are smaller than comparable motors with similar rating.
The built-in, DSP based drive is a step forward in power drive miniaturization. According to the established Phase drive technology, neither electrolytic capacitors nor any components subject to ageing of temperature decay are used. All magnetic are planar, integrated in the drive PCB.
The drive is an ultra compact, single board unit in high density SMD technology with no massive components. The drive is conformal coated and sealed; connection is via IP 67 industrial circular connectors. The DSP updates motor temperature, power device temperature, and drive ambient temperature.
All these data are available on the communication bus for application monitoring and optimization. Drive loss and EMI are minimized intrinsically by the drive location, with zero wiring stray capacitance and minimized winding capacitance. In general, all servo systems are intrinsically limited in performance by the signal/noise ratio of the encoder signal. In the TW motors, the interpolating drive is positioned in close proximity of the encoder, thus ensuring the best possible position signal quality and integrity; the servo performance is consequently optimal.

1.1 **TW MOTORS** WITH INTEGRATED SERVODRIVE

The CANOpen protocol implementation of the TW series is in full compliance with the standards DS 301 and device profile drives DSP 402v2.0. TW drives are controlled in space, speed or torque. The servo loops are updated at 4 kHz frequency.
In the interpolated mode, a position profile synchronized with other axes is followed with a maximum throughput of 500 samples/sec, corresponding to a maximum mechanical bandwidth of 250 Hz, far in excess of the best mechanical systems available; The TW interpolates points with a second order spline. A separate, programmable, hardwired I/O which overrides all software instructions is provided for machine safety requirements. The 2 wires, optically isolated digital interface, and the suppression of all other interfaces, grants reliability, fault tolerance and easy of installation, especially in multi axis systems.
The motors can be programmed and monitored via the CAN Cockpit configuratore windows interface (supplied with all TW motors). All TW motors have a non volatile memory to store permanent data, settings and fault conditions irrespective of power supply availability.

TW Motor with integrated servodrive including:

» absolute multi-turn (N), absolute single-turn (M) encoder or two-poles resolver (R);
» optional integrated holding brake (B);
» optional shaft forelock (K);
» CANOpen compatible (CiA DS301 V4.02 and DSP402 V2.0) drive, profile position, profile velocity, homing mode, interpolated mode, rotary table and torque profile (Tw specific);
» EtherCAT (COE) Module (with optional digital board)
» default values on the parameters table (§**4**).

For details and informations please refer to:
http://www.phase.eu/-Ultract-TW,67-

1.2 OPTIONAL CAN IXXAT **INTERFACE MODULE**

The **Cockpit** configuration tool is useful to create, analyze, modify and copy all parameters for your applications. This tool has to be installed on a PC, with the **CanUsb-Ixxat converter**. The Cockpit configurator is able to:
» access to all functionalities and to all parameters of the drive;
» identify the unit ID number by the CiA DSP305 V1.1 (Layer Setting Services protocol);
» read all parameters from the drive and save them into backup file *.par;
» download the firmware release;
» makes powerful diagnostic with the **Monitor Page**, **Monitor window** and **Graphic window** functions.

The Cockpit could be used simultaneously with other devices in the CAN network only if there is no other systems that try to access via SDO protocol the same TW that Cockpit is addressing (§**4**).

Additionally, with the provided MiniMon Ixxat tool, it is possible to sniffer the traffic on the CAN bus and to realize customized messages.

1.3 OPTIONAL BRAKE UNIT AND POWER SUPPLY

This device make straightforward the commissioning of the Tw motors, as it combine in one system a power supply (EMI filter + rectifier bridge + capacitor filters, input supply of 220/380Vac, output supply of 310/560Vdc, short-circuit protected), a capacitors pre charge and a clamp unit. It can supply at the same time more than one TW. The EMI filter is effective up to a maximum of two TW motors.

2

ELECTRICAL INSTALLATION

Phase Motion Control
TW Motors with Integrated Servodrive

2.1 GENERAL CONNECTIONS DESIGN

For the commissioning the Tw motor need only two connections: supply connection (power / holding brake / auxiliary digital input) and signal connection (CAN bus, passthrough male and female M12 connectors).

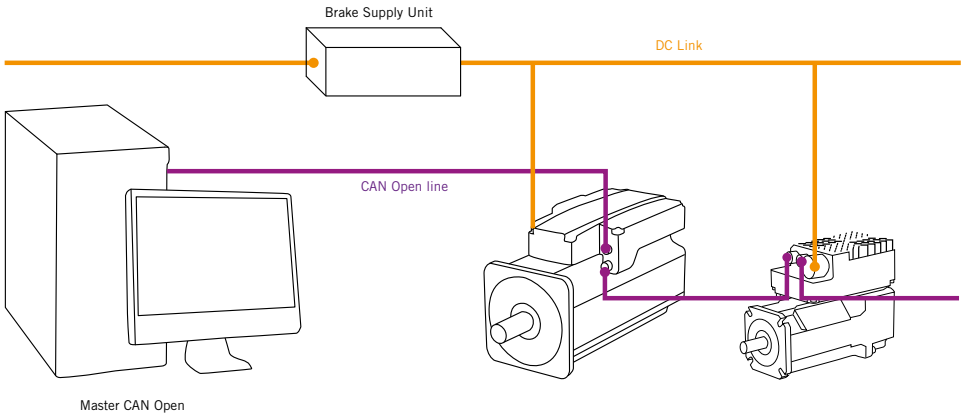


Figure 1
General connections design (TW03A and TW07 motors) CANOpen communication

2.2 POWER CONNECTIONS

The integrated servodrive is designed to work with a 540Vdc supply (that is the resulting rectified and filtered 380Vac) on TW3 motors version.

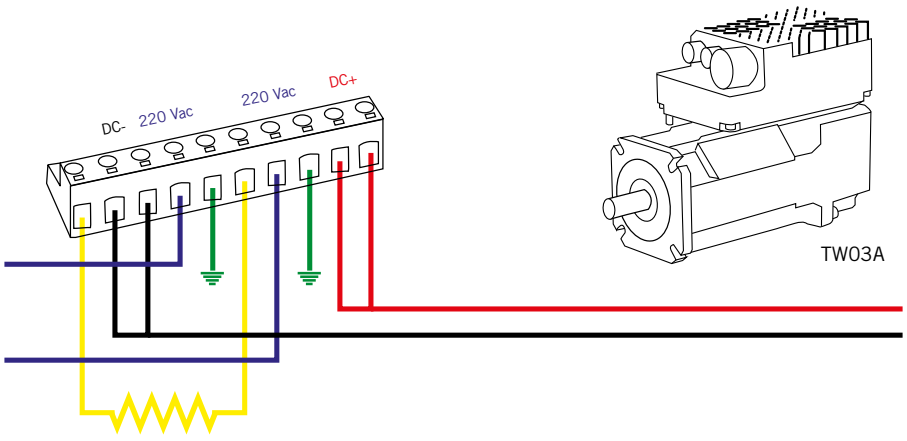


Figure 2
Power connections sample (TW03A motors) with TW-S Single Phase Supply

No clamp resistor is integrated into the motor. If the working cycle of the motor requires a significant braking energy dissipation, a bigger capacitor or an **external clamp device** should be installed on the DC bus.

Both power supply and clamp device are done by the **optional Brake Unit and Power Supply module**, as shown in the Figure 2.

A nominal current's sized **shielded cable** (high-flessibility kind suggested) is required for the system reliability.

For **EMI reduction** an external filter (like Schaffner) between AC connection and rectifier should be installed. However, if the system employs the Brake Unit and Power Supply Module, it has a built-in filter suitable up to two motor.

On TW power connector there is also the software configurable **auxiliary digital input** that could be used either as emergency stop or as input to sample internal values by external event nor as zero point switch in the homing procedures.

When requested, on TW power connector there are also the **holding brake** commands. For proper operation the holding brake have to be supplied with a 24Vdc; inside the Tw this voltage is galvanic fully isolated from the power supply and from the other signals.

2.3 SIGNAL CONNECTIONS: CAN PROTOCOL

The CAN bus is a network, resistor terminated at the beginning and at the ending side, that pass through all devices that is linked to the net. It is necessary a **twisted pair** cable (high-flessibility and shielded kind suggested) with line impedance equal to 120Ω; if the overall network is longer than 25m, it is required right size wires to avoid excessive power loss, as stated in the following table (referred to a network with no more than 64 nodes):

Bus length [m]	Resistance per length unit [mΩ/m]	Wires size [mm2 (AWG)]	Termination resistor (RT) [Ω]	Baudrate [kbit/s]
0...40	70	0.25...0.34 (23...21)	124	1000 at 40 m
40...300	<60	0.34...0.6 (21...19)	150...300	>500 at 100 m
300...600	<40	0.5...0.6 (20...19)	150...300	>100 at 500 m
600...1000	<26	0.75...0.8 (19...18)	150...300	>50 at 1 km

In the Tw motor, in order to let an easier harnessing, there are two M12 connectors, one male and one female. All signals on the connectors are opto-isolated. The power supply of the signal interface is self-generated (thus voiding an external specific power supply) and it is galvanically isolated from the main drive.

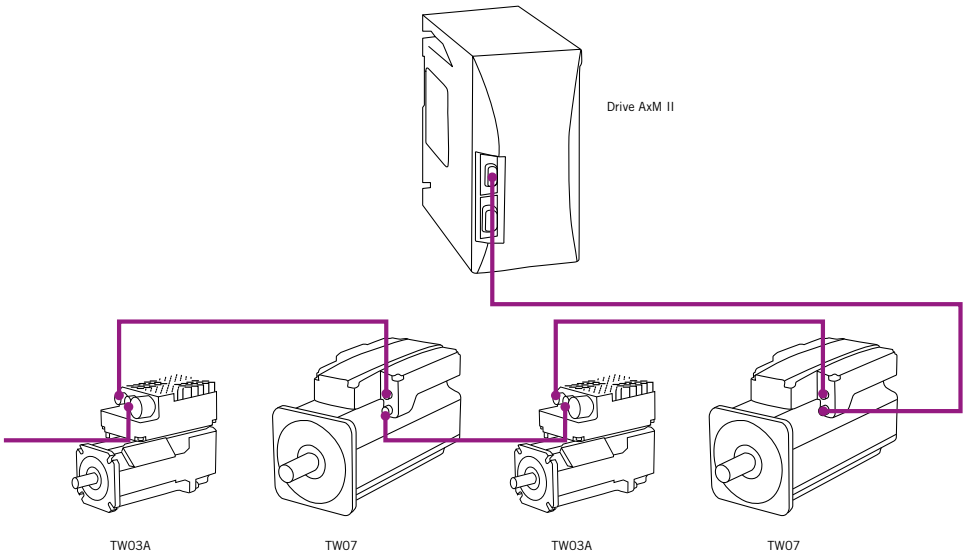


Figure 3
Signal connections sample: CAN protocol.

In the previous drawing is illustrated an interconnection sample between different CAN devices (four TW motors, one AxM servodrive).
For more details refer to (§**1**) and to (§**4**).

2.4 SIGNAL CONNECTIONS: **ETHERCAT PROTOCOL**

The EtherCAT technology overcomes the system limitations of other Ethernet solutions: the Ethernet packet is no longer received, then interpreted and copied as process data at every connection. Instead, the Ethernet frame is processed on the fly: the newly developed FMMU (fieldbus memory management unit) in each slave node reads the data addressed to it, while the telegram is forwarded to the next device. Similarly, input data is inserted while the telegram passes through. The telegrams are only delayed by a few nanoseconds. EtherCAT can provide the same communication mechanisms as the familiar CANOpen mechanisms: object dictionary, PDO (process data objects) and SDO (service data objects) - even the network management is comparable. For more details refer to (§**6**).

EtherCAT IN and OUT connection (M12 Input/Output).
Each EtherCAT slave has two M12 connectors. The left port is the output (OUT) and the right port (IN) is the input (OUT) of the slave. The incoming cable (from the direction of the master) is connected using the IN port, and the outgoing cable is connected to the next slave using the OUT port. The OUT port remains blank for the last slave in the series. An open output on a slave leads internally to a logical short circuit of the transmit (Tx) and receive (Rx) cables. For this reason every EtherCAT network can be regarded as a logical ring in terms of its topology.

3

SOFTWARE

Phase Motion Control
TW Motors with Integrated Servodrive

3.1 MOTOR LED BEHAVIOUR

The TW Motor is equipped with two couples of leds, which indicate the motor status (led on the upper and lower side of the motor give redundant information, except when different noted).

Figure 4
Led identifications

Led1	Led2	Motor Status
Blinking	Off	Power supply Ok. Power output disabled
On	Blinking	Power supply Ok. Power output enabled
Blinking alternately		Fault condition
Blinking simultaneously		Waiting for firmware download (due to Firmware download activation or wrong firmware CRC check)
Off	Two fast blink	Low DC link circuit voltage
On (one side)	Off (both side)	Flash memory corrupted, contact technical service

3.2 **DRIVE** FUNCTIONALITY

The TW Motor complies with the CAN 2.0A standard, with 11 bit identifier; furthermore it complies with the CiA DS301 V4.02 (Application Layer and Communication Profile), with the following functionalities:

NMT:	Slave only
Baud rate / node-ID:	1000 / 800 / 500 / 250 / 125 / 100 / 50 kbps; node 1 ÷ 127
Server SDO:	1
Tx PDO:	8
Rx PDO:	8
PDO Mapping:	User programmable (only in pre-operational state)
PDO Modes:	All types supported
Emergency object:	Yes
Sync object:	Yes
Time object:	No
Error control protocols:	Boot-up / Node Guarding / Heartbeat

The TW Motor complies with some functionalities of the CiA DSP402 V2.0 (Device Profile Drives and Motion Control), that are:

- Profile position mode.
- Profile velocity mode.
- Interpolated position mode.
- Factor group.
- Homing mode.

The baud rate and node-id setting are provided by the CiA DSP305 V1.1 (Layer Setting Services protocol).

The TW Motor specific functions are:

- Absolute multi-turn or absolute single-turn encoder.
- Torque (current) mode.
- Auxiliary digital input for emergency disable.
- 2nd order digital filters.
- Rotary table control.

3.3. STANDARD **CANOPEN SETTING**

Setting the node number and baud rate is supported by the protocol CiA DSP305 V1.1 (Layer Setting Services protocol).
The factory default setting for the TW Motor is the following:

Node number: 1.
Baud rate: 125 kbps (according to CiA DS301 V4.02).

4

TW MOTORS
TW3A02 MODEL

Phase Motion Control
TW Motors with Integrated Servodrive

4.1 TECHNICAL DATA

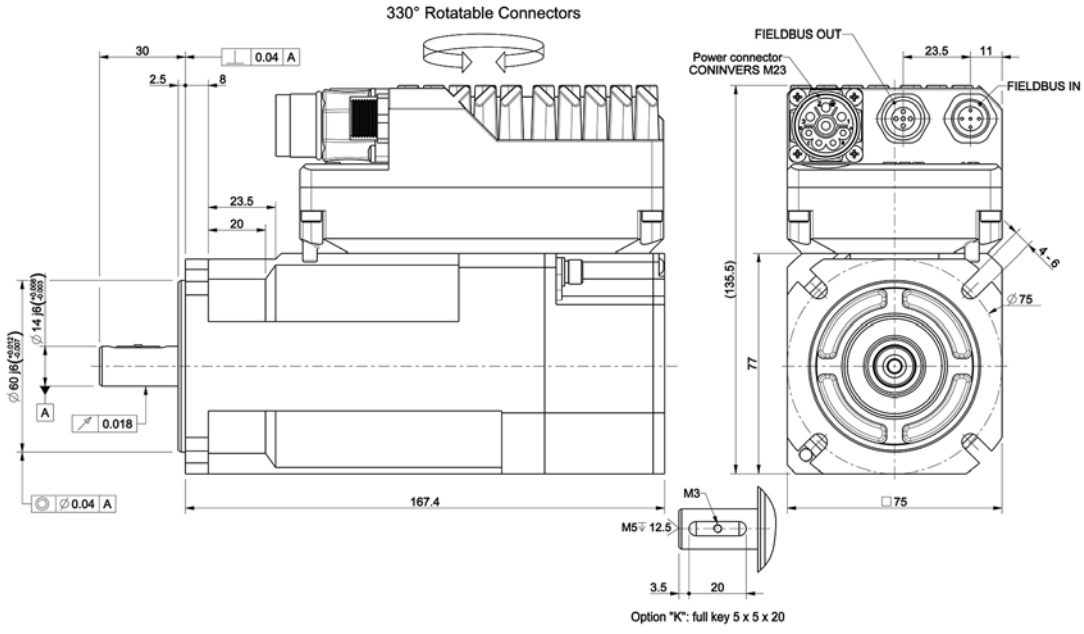
High torque density, small size, low inertia, high voltage supply, high speed.
Torque continuous 2.50 Nm, peak 6.30 Nm.
Maximum power density 650 W in 2.8 kg including drive 5000 rpm operation.
Small diameter for limited pitch multi axis applications.
310 Vdc and 550 Vdc bus compatible.
Universal 14 mm shaft with half key.
The servodrive is produced with resolver (2 poles) or encoder Heidenhain inductive absolute mono (ECI1319) or multi (EQI1331).
IP 67 protection.

Applications:

- Workpiece setting for wood and metal forming.
- Packaging, bottling, wrapping, especially on rotary machines (single wire commend for multi axis).
- Tool changers.
- Laser plotter.
- Pick and place robots.
- Mould automation.
- Assembly machines .

4.2 MECHANICAL DRAWINGS.

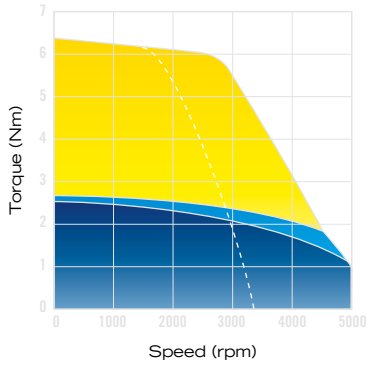
All measurements are in mm, except when specified.



TW motor	TW3A02.50.4	TW3A02.50.4.B	Units
L1	167.4	197.4	[mm]
L2	197.4	227.4	[mm]

(*) **Option B**: dimension integrated brake.

4.3 TORQUE (NM) VERSUS SPEED (RPM)



TW 3A02.50.4

- Torque cont. S1 (flanged)
- Torque cont. S1 (free air)
- Torque max S6 10% (flanged)

Torque (Nm) curve versus speed motor (rpm), 400 Vac drive
* Motor mounted on steel flange, temperature flange <= 60°C.

4.4 MOTOR/DRIVE TECHNICAL DATA

Reference data (winding independent)	Symbol	3A02.50.4	Units
Nominal Torque, S1, low speed, free air 1)	Tnc	2.40	Nm
Nominal Torque, S1, low speed, flanged 2)	Tnw	2.58	Nm
Peak Torque, S6 10% 1)	Tpk	6.10	Nm
Max. Saturation Speed	Pn	7161	rpm

Physical data (winding independent)	Symbol	3A02.50.4	Units
Rotor inertia	Jm	0.085	$mkgm^2$
Acceleration at peak torque	Apk	67000	rad/s^2
Mass	Msta	2.52	Kg
Insulation		Class H-F	
IP Protection		IP67	

Thermal data (winding independent)	Symbol	3A02.50.4	Units
Thermal time constant, free air 1)	Tc	400	sec
Thermal time constant, flanged 2)	Tw	222	sec
Motor loss at Tnc	LOc	80	W
Motor loss at Tnw	Low	65	W
Threshold of built-in PTC	PTCt	130	°C

Electrical data (winding dependent)	Symbol	3A02.50.4	Units
Power supply (typical)	Vn	560	Vdc
Rated speed	Wn	5000	rpm
Peak current T=Tpk	Ipk	5.37	Arms
Nominal current at T=Tn	In	2.40	Arms
Maximum power at 4000 rpm	Pnw	0.80	kW
Torque constant	Kt	1.175	Nm/A

Brake Data (optional)	Symbol	3A02.50.4	Units
Supply voltage	Un	24	V
Power consumption	P20	13	W
Stall braking torque	Tbk	7.00	Nm
Additional Inertia	JBk	0.041	$mkgm^2$

1) Motor in free still air (worst case), ambient 40 °C, copper 130 °C, frame 105 °C.
2) Motor mounted on steel flange, temperature flange <= 60°C.

4.5 CONNECTIONS

Figure 5
TW3A02: power connector on the motor, view from insertion side

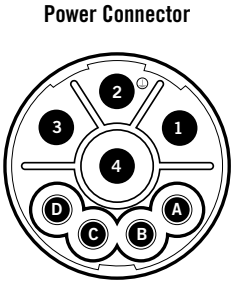
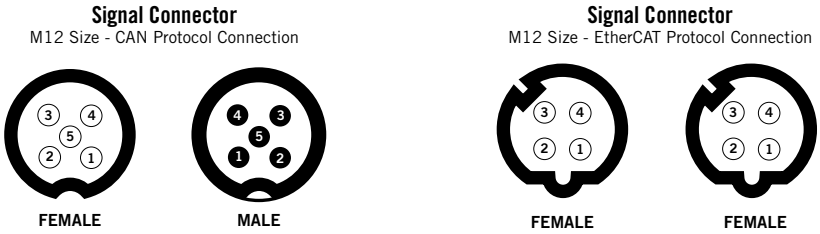


Figure 6
TW3A02: signal connectors on the motor, view from insertion side: CAN protocol connection

Figure 7
TW3A02: signal connectors on the motor, view from insertion side: EtherCAT protocol connection



Power connector		Signal connectors			
		CANOpen protocol		EtherCAT protocol	
CONINVERS 8 pins SF-7EP1N8AWA00 MR23		M12 Codification A		M12 Codification D	
Pin	Description	Pin	Description	Pin	Description
1	DC+	1	Shield	1	Tx+
2	GND	2	+ 24 V Supply	2	Rx+
3	DC -	3	CAN GND / O V Supply	3	Tx-
4	O V Supply	4	Can-H	4	Rx-
A	+24 V Input Torque H	5	Can-L		
B	Auxiliary Input (+24 V)				
C	+24 V Supply				
D	+24 V Input Torque L				

Note:
Voltage power supply 24 V can be connected alternately with pins 2 and 3 of the M12 connector (in CAN protocol version), or to pins C and 4 of the power connector.
If you are not using the functionality of the SAFE pin A and D of the power connector must also be supplied with 24V auxiliary.

5

TW3A02 MODEL **SAFETY FUNCTION PERFORMANCE**

Phase Motion Control
TW Motors with Integrated Servodrive

5.1 **TW3 LABELLING** / SERIAL NUMBER AND CONFIGURATION CONTROL

Nomenclature:

3 digits that identify those who assembles the product	PHS
3 digits that identify the product	003
4 digits that identify Year and Week of production	YYWW
6 digits that identify the serial number	XXXX

5.2 STO FUNCTIONAL REQUIREMENTS

The STO function is implemented in hardware and overrides all software activities. The only software involvement is to report STO status to the user by the communication with the software.
In standard conditions STO function requires two separate +24 Vdc applied to dedicated pins. This function is anyway guaranteed from +6,5 Vdc to +35Vdc.
STO circuits are protected from polarity inversion.
Power, that can cause rotation, is not applied to the motor. The PDS(SR) will not provide energy to the motor which can generate torque.
STO corresponds to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1.
This safety function may be used where power removal is required to prevent an unexpected start-up.
In circumstances where external influences (for example, falling of suspended loads) are present, additional measures (for example, mechanical brakes) may be necessary to prevent any hazard.

5.2.1. Real time processing

If one of the control voltages (or both of them) is interrupted, energy supply to the motor is switched off and the disconnection is effected at a delay of less than 10ms.

5.2.2. Mode management:

The STO function is one fault fail-safe. No single fault of components can enable the drive to produce motor shaft torque. Only in extremely unlike combination of component faults the motor shaft could move jerky with sudden acceleration (maximum 180°/number pole pairs) and produce torque. It must be checked if this behaviour can cause a dangerous machine movement.
STO function is not a brake function, after the disconnection of the power from the motor it could continue to rotate as a result of system's inertia.

5.2.3. Location identification

STO circuits are independent each other and from the rest of drive.

5.2.4. Supervisor functions

Software is able to detect if one (or both) safe voltage supplies are interrupted and generates an appropriate diagnostic message but it isn't involved in the safety function.

5.2.5. Maintenance

Include the STO operation test to the routine maintenance program of the machinery that the drive runs. The STO function or STO input terminals do not need any maintenance. Maintain the drive according to the instructions given in the User Manual.

5.2.6. Power-on time

Power-on time of STO circuit is in the order of 400µs.

5.2.7. Power on integrity self tests

The system is designed with intrinsic safe principle. Software has only diagnostic purpose, the safety is warranted by hardware circuit. Software is able to detect a missing STO input in about 20ms and activate a diagnostic alarm condition.

5.2.8. Operating environment requirements

INGRESS PROTECTION CODE
PDS is class IP 67 protected.

TEMPERATURE
STO function is guaranteed in a range of temperatures from -20°C to 65°C ambient.
Diagnostic can check drive's temperature, winding's temperature and the temperature of the power module(IGBT). If these values exceed the set values PDS goes in alarm state and the power is disabled.

RELATIVE HUMIDITY
PDS maintains its correct functionality from 0% to 95% of relative humidity.

SHOCK AND VIBRATION
PDS can sustain vibrations of 0.5 g in every directions, 0 - 10 Hz and shocks for the value of 1g.

ELECTROMAGNETIC COMPATIBILITY
This product accords to:

EMC Directive 2004/108/CE

Then it satisfies the requirements of:

EN 61000-4-2 ESD
EN 61000-4-3 Radiated disturbances, radiofrequency, electromagnetic field
EN 61000-4-4 Burst
EN 61000-4-5 Surge
EN 61000-4-6 Conducted, induced by radio-frequency fields
EN 61800-3

STO function operates from

	-35Vdc to +35Vdc
Logic threshold	+6,5Vdc to +35Vdc
Typical input current at +24Vdc (each single circuit)	10mA
Response time at nominal voltage:	8ms

5.3. TESTING

5.3.1. Type tests:

STO function will be tested in the operating temperature range.

- power-on time:
- real time processing
- power cut-off time
- min/max STO input activation voltage

will be checked to verify if they accord to values expressed in datasheets.

5.3.2. Routine tests

Test machines, which are normally used for routine tests during production phase, tests STO function by the interruption of safe voltages signals before the burn in test end after that.

5.4. DOCUMENTATION

5.4.1. Quality assurance

Quality procedures according to the ISO 9001 Standard requirements.

5.4.2. IEC EN 61800-5-2:2007

STO function on TW03 motor accords to IEC EN 61800-5-2:2007

5.4.3. PFH

STO function on TW0003 motor at 60°C has PFHdtot = 2,79E-08 (it comes from fault tree analysis)

5.4.4. SIL CAPABILITY

The comparison between PFH value, SFF value and HFT value shows that STO function on TW03 motor reach a level of SIL3.

6

TW MOTORS
TW05A MODELS

Phase Motion Control
TW Motors with Integrated Servodrive

6.1 TECHNICAL DATA

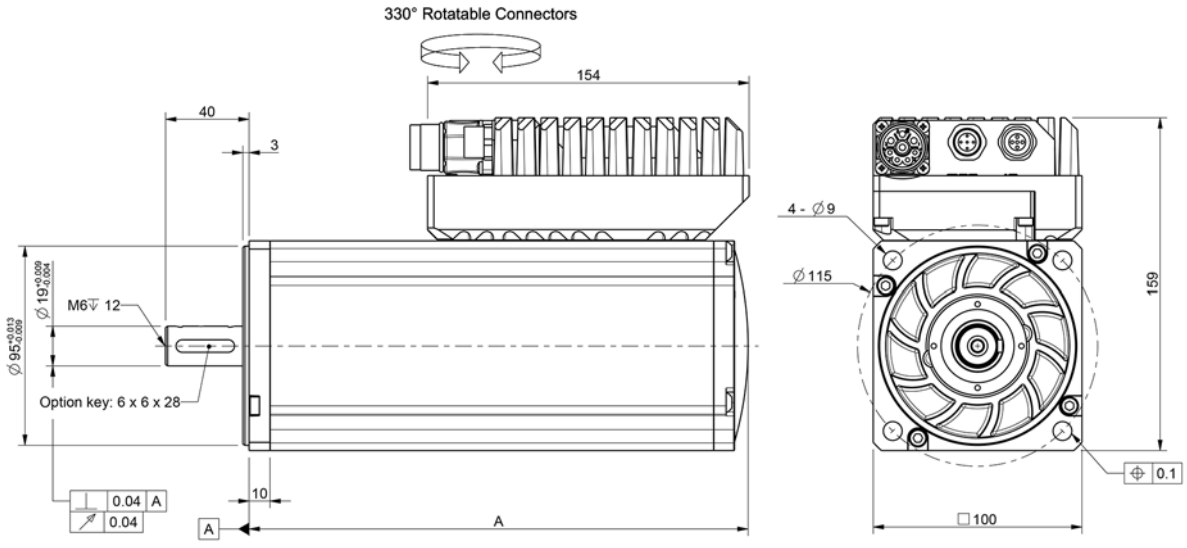
High torque density, small size, low inertia, high voltage supply, high speed.
Torque continuous 3/8 Nm, peak 8/20 Nm.
Maximum power density 1,6 KW in 9 kg including drive 3000 rpm operation.
Small diameter for limited pitch multi axis applications.
310 Vdc and 550 Vdc bus compatible.
Universal 19 mm shaft with half key.
The servodrive is produced with resolver (2 poles) or encoder Heidenhain inductive absolute mono (ECI1319) or multi (EQI1331).
IP 67 protection.

Applications:

- Workpiece setting for wood and metal forming.
- Packaging, bottling, wrapping, especially on rotary machines (single wire commend for multi axis).
- Tool changers.
- Laser plotter.
- Pick and place robots.
- Mould automation.
- Assembly machines.

6.2 MECHANICAL DRAWINGS

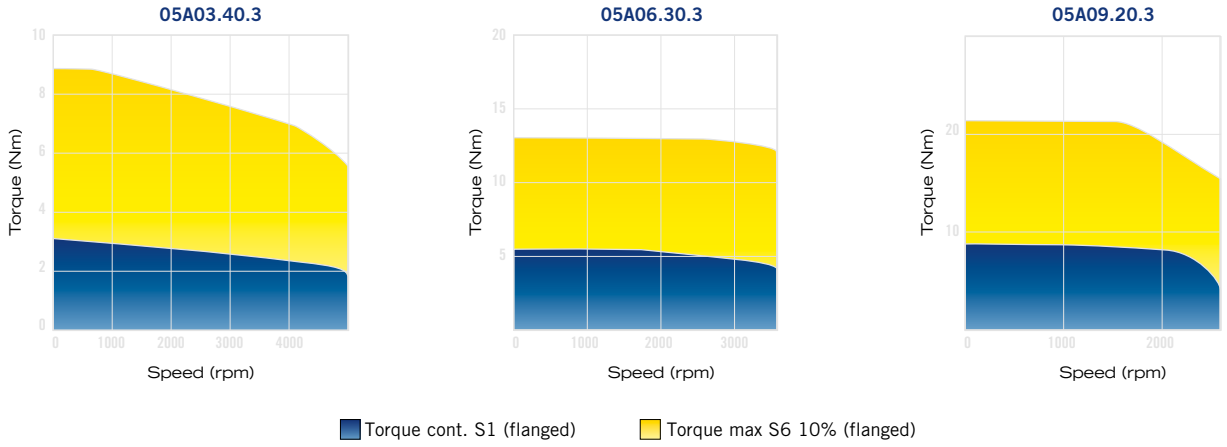
All measurements are in mm, except when specified.



Type	A	B (*)	Units
05A03.40.3	195	228	[mm]
05A06.30.3 (1)	239	272	[mm]
05A09.20.3	279	312	[mm]

(*) **Option B**: dimension integrated brake.
(1) The TW05A motor represented in the previous figure is **05A06.30.3**.

6.3 TORQUE (NM) VERSUS SPEED (RPM)



6.4 MOTOR/DRIVE **TECHNICAL DATA**

Reference data (winding independent)	Symbol	05A03.40.3	05A06.30.3	05A09.20.3	Units
Nominal Torque, S1, low speed, free air 1)	Tnc	3.06	5.32	8.54	Nm
Continuous Torque, at low speed	Tnw	2.94	5.32	8.54	Nm
Peak torque, S6 10% 1)	Tpk	8.84	12.94	20.68	Nm
Max. Saturation Speed	Pn	6000	4000	3000	rpm

Physical data (winding independent)	Symbol	05A03.40.3	05A06.30.3	05A09.20.3	Units
Rotor inertia	Jm	$1.81 \cdot 10^{-4}$	$3.15 \cdot 10^{-4}$	$4.49 \cdot 10^{-4}$	kgm^2
Acceleration at peak torque	Apk	$7.99 \cdot 10^{4}$	$9.19 \cdot 10^{4}$	$9.66 \cdot 10^{4}$	rad/s^2
Mass	Msta	4.01	6.39	8.88	Kg
Insulation			Class H		
IP protection			IP 67		

Thermal data (winding independent)	Symbol	05A03.40.3	05A06.30.3	05A09.20.3	Units
Thermal time constant, free air 1)	Tc	706.52	847.69	939.68	sec
Motor loss at Tnc	LOc	69.6	77.97	116.53	W
Threshold of built-in PTC	PTCt	130	130	130	°C

Electrical data (winding dependent)	Symbol	05A03.40.3	05A06.30.3	05A09.20.3	Units
Power supply (typical)	Vn	540	540	540	Vdc
Rated speed	Wn	5000	3000	2000	rpm
Peak current T=Tpk	Ipk	8.0	8.0	8.0	Arms
Nominal current T=Tn	In	3.2	3.2	3.2	Arms
Nominal power, S1 at rated speed	Pnw	0.96	1.1	1.68	kW
Torque constant	Kt	1.268	1.776	2.854	Nm/A

1) Motor in free still air (worst case), ambient 40 °C, copper 130 °C, frame 105 °C.

6.5 CONNECTIONS

Figure 8
TW05A: power connector on the motor, view from insertion side

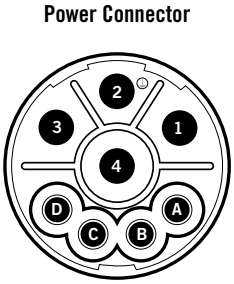
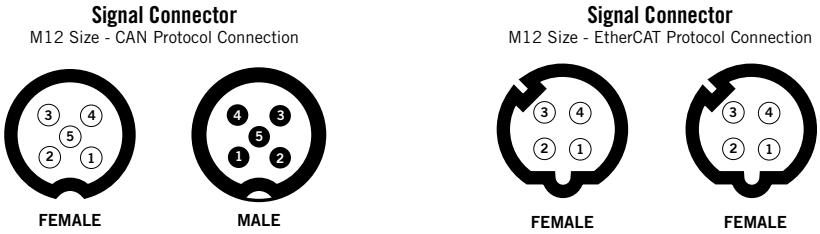


Figure 9
TW05A: signal connectors on the motor, view from insertion side: CAN protocol connection

Figure 10
TW05A: signal connectors on the motor, view from insertion side: EtherCAT protocol connection



Power connector		Signal connectors			
		CANOpen protocol		EtherCAT protocol	
CONINVERS 8 pins SF-7EP1N8AWA00 MR23		M12 Codification A		M12 Codification D	
Pin	Description	Pin	Description	Pin	Description
1	DC+	1	Shield	1	Tx+
2	GND	2	+ 24 V Supply	2	Rx+
3	DC -	3	CAN GND / O V Supply	3	Tx-
4	O V Supply	4	Can-H	4	Rx-
A	+24 V Input Torque H	5	Can-L		
B	Auxiliary Input (+24 V)				
C	+24 V Supply				
D	+24 V Input Torque L				

Note:
Voltage power supply 24 V can be connected alternately with pins 2 and 3 of the M12 connector (in CAN protocol version), or to pins C and 4 of the power connector.
If you are not using the functionality of the SAFE pin A and D of the power connector must also be supplied with 24V auxiliary.

7

TW MOTORS
TW07 MODELS

Phase Motion Control
TW Motors with Integrated Servodrive

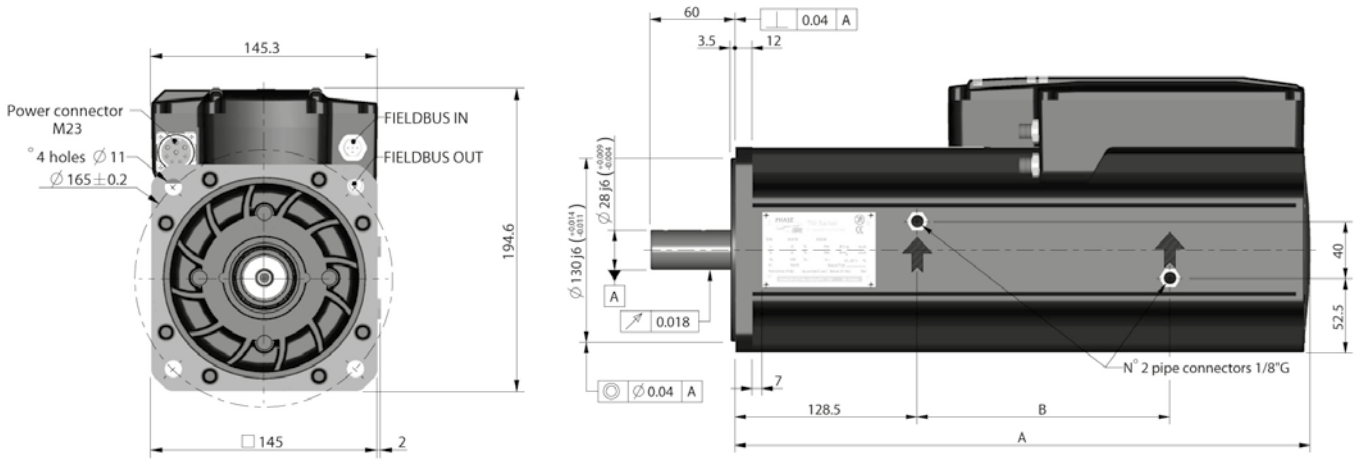
7.1 **TECHNICAL** DATA

The new integrated servo TW07 is able to deliver 20 kW and 65 Nm continuous, 30 kW overload. The system is water-cooled with a single circuit that affects both the motor as the drive so integrated that reaches levels of extreme compactness and power density, making it ideal for high power applications in confined spaces and enabling the elimination of the cabinet, as well as application self-propelled vehicle or rotary tables, with connections to minimize and control via fieldbus.
The servodrive is produced with resolver (2 poles) or encoder Heidenhain inductive absolute mono (ECI1319) or multi (EQI1331).
Option available: brake for vertical axis.

The TW series is particularly innovative with regard to electromagnetic compatibility. There are no cables between motor and drive also between the sensor and drive through the integration, so that the system has a very low RFI emissions and an equally reduced susceptibility to electromagnetic interference.
The drive is designed and validated for a high-level of vibration and temperature, and works completely without electrolytic capacitors, which enables a particularly high lifetime.
The system is class IP 67 protected.

7.2 **MECHANICAL** DRAWINGS.

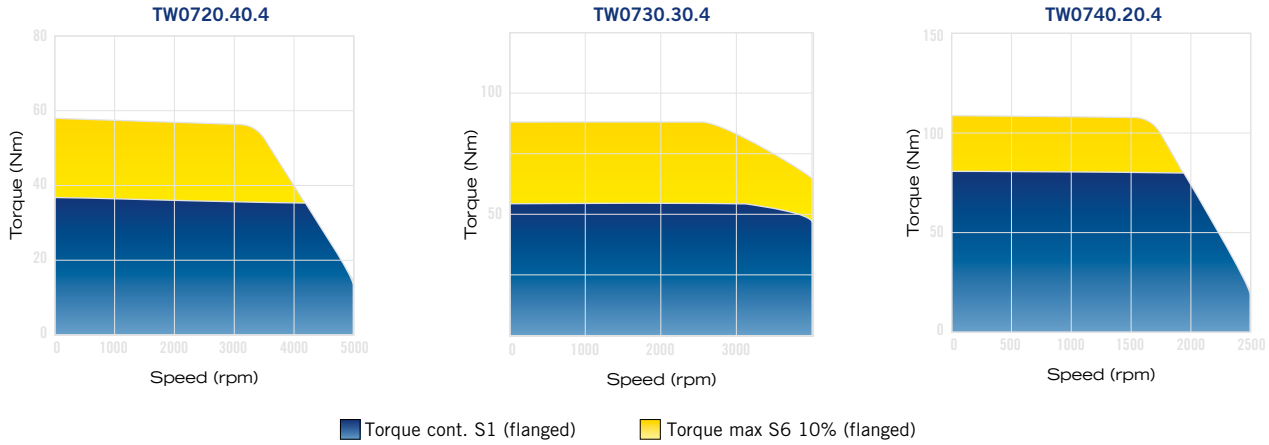
All measurements are in mm, except when specified.



Type	A	B	C (*)	D (*)	Units
TW0720	305.2	76.5	355.2	126.5	[mm]
TW0730	355.2	127.5	405.2	177.5	[mm]
TW0740	406.2	178.5	456.2	228.5	[mm]

(*) **Option C-D**: dimension integrated brake.

7.3 TORQUE (NM) VERSUS SPEED (RPM)



7.4 MOTOR/DRIVE **TECHNICAL DATA**

Reference data (winding independent)	Symbol	TW0720.40.4	TW0730.30.4	TW0740.20.4	Units
Nominal Torque, S1, low speed, water cooled H20	Tnc	36,3	55,4	80,5	Nm
Peak torque, S6 10% 1)	Tpk	57,3	73,9	107,5	Nm
Max. Saturation Speed	Pn	6000	6000	6000	rpm

Physical data (winding independent)	Symbol	TW0720.40.4	TW0730.30.4	TW0740.20.4	Units
Rotor inertia	Jm	$1{,}29 \cdot 10^{-3}$	$1{,}85 \cdot 10^{-3}$	$2{,}41 \cdot 10^{-3}$	kgm^2
Acceleration at peak torque	Apk	$5{,}07 \cdot 10^{4}$	$5{,}30 \cdot 10^{4}$	$5{,}42 \cdot 10^{4}$	rad/s^2
Mass	Msta	13	18	23	Kg
Insulation			Class H		
IP protection			IP 67		

Thermal data (winding independent)	Symbol	TW0720.40.4	TW0730.30.4	TW0740.20.4	Units
Thermal time constant, water-cooled H20 1)	Tc	372	329	308	s
Motor loss at Tnc	LOc	$0.86 \cdot 10^{3}$	$1.29 \cdot 10^{3}$	$1.71 \cdot 10^{3}$	W
Motor loss at Tnw	LOw	$1.02 \cdot 10^{3}$	$1.44 \cdot 10^{3}$	$1.83 \cdot 10^{3}$	W
Threshold of built-in PTC	PTCt	130	130	130	°C

Electrical data (winding dependent)	Symbol	TW0720.40.4	TW0730.30.4	TW0740.20.4	Units
Power supply (typical)	Vn	540	540	540	Vdc
Rated speed	Wn	4000	3000	2000	rpm
Peak current T=Tpk	Ipk	48	48	48	Arms
Nominal current T=Tn	In	30	36	36	Arms
Rated power	Pnw	14	17	20	kW
Torque constant	Kt	1,35	1,71	2,50	Nm/A

Brake Data (optional)	Symbol	TW0720.40.4	TW0730.30.4	TW0740.20.4	Units
Supply voltage	Un	24	24	24	V
Power consumption	P20	22.8	22.8	22.8	W
Stall braking torque	Tbk	58	58	58	Nm
Additional Inertia	Jbk	$0.13 \cdot 10^{-3}$	$0.13 \cdot 10^{-3}$	$0.13 \cdot 10^{-3}$	kgm^2

1) Motor water-cooled with 30°C water temperature.

2) Connector cooling water-pipe: opposite inlet and outlet version.

7.5 CONNECTIONS

Figure 11
TW07: power connector on the motor, view from insertion side

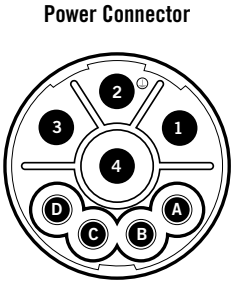
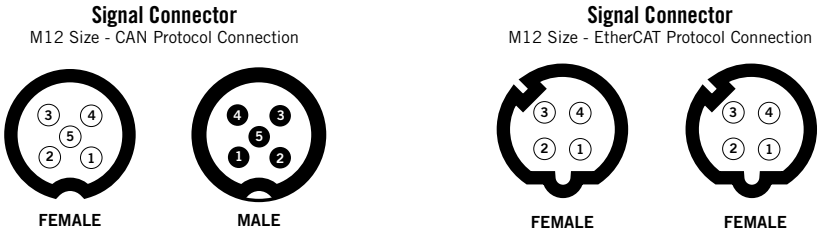


Figure 12
TW07: signal connectors on the motor, view from insertion side: CAN protocol connection

Figure 13
TW07: signal connectors on the motor, view from insertion side: EtherCAT protocol connection



Power connector		Signal connectors			
		CANOpen protocol		EtherCAT protocol	
CONINVERS 8 pins SF-7EP1N8AWA00 MR23		M12 Codification A		M12 Codification D	
Pin	Description	Pin	Description	Pin	Description
1	DC+	1	Shield	1	Tx+
2	GND	2	+ 24 V Supply	2	Rx+
3	DC -	3	CAN GND / O V Supply	3	Tx-
4	O V Supply	4	Can-H	4	Rx-
A	+24 V Input Torque H	5	Can-L		
B	Auxiliary Input (+24 V)				
C	+24 V Supply				
D	+24 V Input Torque L				

Note:
Voltage power supply 24 V can be connected alternately with pins 2 and 3 of the M12 connector (in CAN protocol version), or to pins C and 4 of the power connector.
Input Torque pin A and D of the power connector must also be supplied with 24V auxiliary.

8

TW07 MODELS
SAFETY FUNCTION PERFORMANCE

Phase Motion Control
TW Motors with Integrated Servodrive

8.1 **TW07 LABELLING** / SERIAL NUMBER AND CONFIGURATION CONTROL

Nomenclature:

3 digits that identify those who assembles the product	002
3 digits that identify the product	071
4 digits that identify Year and Week of production	YYWW
6 digits that identify the serial number	XXXXXX

8.2 STO FUNCTIONAL REQUIREMENTS

The STO function is implemented in hardware and overrides all software activities. The only software involvement is to report STO status to the user by the communication with the software.
In standard conditions STO function requires two separate +24 Vdc applied to dedicated pins. This function is anyway guaranteed from +6,5 Vdc to +35Vdc.
STO circuits are protected from polarity inversion.
Power, that can cause rotation, is not applied to the motor. The PDS(SR) will not provide energy to the motor which can generate torque.
STO corresponds to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1.
This safety function may be used where power removal is required to prevent an unexpected start-up.
In circumstances where external influences (for example, falling of suspended loads) are present, additional measures (for example, mechanical brakes) may be necessary to prevent any hazard.

8.2.1. Real time processing

If one of the control voltages (or both of them) is interrupted, energy supply to the motor is switched off and the disconnection is effected at a delay of less than 10ms.

8.2.2. Mode management:

The STO function is one fault fail-safe. No single fault of component failure can cause enabled drive to produce motor shaft torque. Only in extremely unlike combination of component faults the motor shaft could move jerky with sudden acceleration (maximum 180°/ number pole pairs) and produce torque. It must be checked if this behaviour can cause a dangerous machine movement.
STO function is not a brake function, after the disconnection of the power from the motor it could continue to rotate as a result of system's inertia.

8.2.3. Location identification

STO circuits are independent each other and from the rest of drive.

8.2.4. Supervisor functions

Software is able to detect if one (or both) safe voltage supplies are interrupted and generates an appropriate diagnostic message but it isn't involved in the safety function.

8.2.5. Maintenance

Include the STO operation test to the routine maintenance program of the machinery that the drive runs. The STO function or STO input terminals do not need any maintenance. Maintain the drive according to the instructions given in the User Manual.

8.2.6. Power-on time

Power-on time of STO circuit is in the order of 400µs.

8.2.7. Power on integrity self tests

The system is designed with intrinsic safe principle. Software has only diagnostic purpose, the safety is warranted by hardware circuit.
Software is able to detect a missing STO input in about 20ms and activate a diagnostic alarm condition.

8.2.8. Operating environment requirements

INGRESS PROTECTION CODE
PDS is class IP 67 protected.

TEMPERATURE
STO function is guaranteed in a range of temperatures from -40°C to 85° inside the aluminium box. Diagnostic can check drive's temperature, winding's temperature and the temperature of the power module (IGBT). If these values exceed the set values PDS goes in alarm state and the power is disabled.
Each size of TW07 motor requires a different coolant flow (water) with a max inlet temperature of 30°C:
TW0720 needs 1.3 liter/min
TW0730 needs 1.9 liter/min
TW0740 needs 2.5 liter/min

RELATIVE HUMIDITY
PDS maintains its correct functionality from 0% to 95% of relative humidity.

SHOCK AND VIBRATION
PDS can sustain vibrations of 0.5 g in every directions, 0 - 10 Hz and shocks for the value of 1g.

ELECTROMAGNETIC COMPATIBILITY
This product accords to:
EMC Directive 2004/108/CE

Then it satisfies the requirements of:
EN 61000-4-2 ESD
EN 61000-4-3 Radiated disturbances, radiofrequency, electromagnetic field
EN 61000-4-4 Burst
EN 61000-4-5 Surge
EN 61000-4-6 Conducted, induced by radio-frequency fields
EN 61800-3
EN 61000-4-6 Conducted, induced by radio-frequency fields
EN 61800-3

STO function operates from:

Absolute maximum voltage range	-35Vdc to +35Vdc
Logic threshold	+6,5Vdc to +35Vdc
Typical input current at +24Vdc (each single circuit)	10mA
Response time at nominal voltage:	8ms

8.3 TESTING

8.3.1. Type tests:

STO function will be tested in the operating temperature range.

- power-on time;
- real time processing;
- power cut-off time;
- min/max STO input activation voltage.

will be checked to verify if they accord to values expressed in datasheets.

8.3.2. Routine tests

Test machines, which are normally used for routine tests during production phase, will be able to test STO function by the interruption of safe voltages signals before the burn in test end after that.

8.4 DOCUMENTATION

8.4.1. Quality assurance

Quality procedures according to the ISO 9001 Standard requirements.

8.4.2. IEC EN 61800-5-2:2007

STO function on TW07 motor accords to IEC EN 61800-5-2:2007

8.4.3. PFH

STO function on TW07 motor at 60°C has PFHdtot = 4,30E-08 (it comes from fault tree analysis)

8.4.4. SIL CAPABILITY

The comparison between PFH value, SFF value and HFT value shows that STO function on TW07 motor reach a level of SIL3.

9

CE CONFORMITY

Phase Motion Control
TW Motors with Integrated Servodrive

Declaration of conformity – Manufacturer's declaration – Installation instructions

This extension group all prescriptions, advices and declarations of the manufacturer in relation to the conformity to EC Directives concerning variable speed servodrive systems.

9.1 INTRODUCTION: EC DIRECTIVES

The EC Directives are manufacturing prescriptions intended to guarantee a standard level of quality, reliability and safety for all industrial goods produced and marketed across the European Union. The EC Directives are general documents that establish base specifications for the certifications, which are subsequently converted into national laws by all member states. A certification issued by a member state is valid automatically in all other member states. Technical details are not included in the directives. They are determined by the relevant European harmonized standards (EN). After verification, affixing a CE mark certifies the conformity to the CE directives. Within the EU there are no commercial barriers for a product with the CE mark. A conformity certificate, however, is generally not required for most directives.
In the field of brushless motor drives, the CE mark is referred exclusively to the Low Voltage Directive. As for the EMCD directive, a drive is only a component and not a system, and the conformity of the system to the EMCD remains the one responsibility of the system designer or user. In order to assist their Customers, Phase Motion Control have already proved and certified the conformity of a CE-typical system to the EMC directive with Tw brushless motors.

9.2 LVD 2006/95/CE

Refer to Low Voltage Directive (LVD 2006/95/CE).

The LVD directive deals with all electrical machines operating in usual environments between 50 and 1000 Vac, and between 75 and 1500 Vdc. This directive does not apply to applications in particular atmospheres and/or anti-explosion machines; also it does not refer to lifting equipment.
The directive's general purpose is to guarantee a uniform electrical safety level from the point of view of user's risk and of possible damage to objects; the directive dictates the product to be supported from the point of view of safety and of application prescriptions.

The Tw Motors servodrive are designed, manufactured and tested in conformity with the Low Voltage Directive 2006/95/CE and under the responsibility of

Phase Motion Control S.p.A., via Adamoli, 461, 16141 Genoa

9.3 EMCD 2004/108/CE

Refer to Electromagnetic Compatibility Directive (EMCD 2004/108/CE).

The EMCD directive relating to electromagnetic compatibility is effective for "equipment" which may either cause electromagnetic disturbances or be affected by such disturbances.

The aim is the limitation of the generation of electromagnetic disturbances so that the operation of radio and telecommunication systems and other equipment is possible and that a suitable immunity of the equipment against electromagnetic disturbances is ensured so that the operation can be achieved.
Controllers cannot be driven in standalone operation and therefore the controllers themselves cannot correspond to the EMC directive. The controllers must be integrated into a drive system to check the compliance with the EC directive relating to EMC of the “Regulation about the electromagnetic compatibility of devices”.

As Components the Tw Motors comply to the IEC 61000-4-2 (2008) - IEC 61000-4-4 (2004) - IEC 61000-4-5 (2006), IEC 61800-3 (2004) without any accessory or protection.

The Tw Motors servodrive are designed, manufactured and tested in conformity with the Electromagnetic Compatibility Directive 2004/108/CE and under the responsibility of

Phase Motion Control S.p.A., via Adamoli, 461, 16141 Genoa

9.4 INSTALLATION

- Transport, installation and use of the drives are reserved to qualified staff (IEC 60364).
- The opening of the drive’s enclosure or motors protections, or a defective installation, can lead to personal or material damage.
- The technical data on the unit’s nameplates must be observed.
- The units must be installed and cooled according to the regulations stated in the corresponding documentation.
- Ensure that no components are bent or insulation distances changed during transport. The electronic components and contacts must not be touched.
- When working on an energized controller the valid national requirements for the prevention of accidents must be observed.
- The electrical installation must comply with applicable regulations (cable cross sections, fuses, protective conductor connections).
- All control inputs and outputs of the drives are insulated with a “basic” insulation (functional). Another level of protection must be implemented for personal safety against electrical contact.
- When using current-operated protective devices, please note that the controller have internal DC rectification. A DC fault current is therefore possible. Some differential current protection systems are made inoperative by DC current leakage. Use only “universal” or pulse operated protection devices. The RFI filter which is built into the drives cause a certain amount of leakage current to flow in the ground wires. This current may cause tripping of too sensitive differential device and need to be taken into account while sizing differential devices.
- Irrespective of the CE mark on the motor, it is reminded that the compliance of the required limit values with the legal EMC regulations remain the responsibility of the manufacturer of the system or machine.
- The RFI filter needs a ground connection. The typical application is not operable without ground connection.
- For installations different from the typical application (e.g.: use of unscreened cables, use of multiple drives, etc.) the conformity to the CE-EMC directive requires a check of the machine or system regarding EMC limit values.
- The user of the machine is responsible for the compliance with the EMC directive.
- Screen all power cables from filters to drive and from drive to motor with shield coverage greater than 85%.
- Signal cables must always be shielded as above.

- In order to reduce the interference caused by the motor cable and the induced noise in the encoder connection cable, such wiring must be shorter than 15 meters. This limitation is necessary also for the protection of the drive itself. For longer cables, use appropriate snubber inductors.
- The shields and grounds connections have to be made on the chassis of the motor, on the specific screws distinguished by ⏚.
- It is important that the power wires are inserted in wire ways different from the signal and supply one and that any cross between the power and signal cables is carried out at right angle.
- If sensitive instruments are used (for example analogue, non preamplified transducers, load cells, thermocouples etc.) keep a safe distance between the instrumentation ground and the power ground.
- All devices (drives, filters, motors) must be grounded on a single ground bar, with ground wires as straight and short as possible.

Note:
Tw Motors servodrive have to use in second environment locations as specified in the CEI EN 61800-3 norm.

"From CEI EN 61800-3
3.2.2 second environment
environment that includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes. NOTE: Industrial areas, technical areas of any building fed from a dedicated transformer are examples of second environment locations."

10

TW ACCESSORIES

Phase Motion Control
TW Motors with Integrated Servodrive

10.1 **TW-S** SINGLE PHASE

10.1.1. Main Features

TW-S Single phase power supply with pre-charge cycle and integral brake unit.
SMD Technology, Single phase supply operation, Single phase supply 220 +/- 20% Vac, Dynamic braking (external resistor required), pre-charge capabilities, Integrated EMC filter, Nominal output voltage 310 Vdc, continuous output power up to 1kW, Nominal braking power up to 1kW, DIN rail mounted, Free air convection cooling.

10.1.2. Technical performance

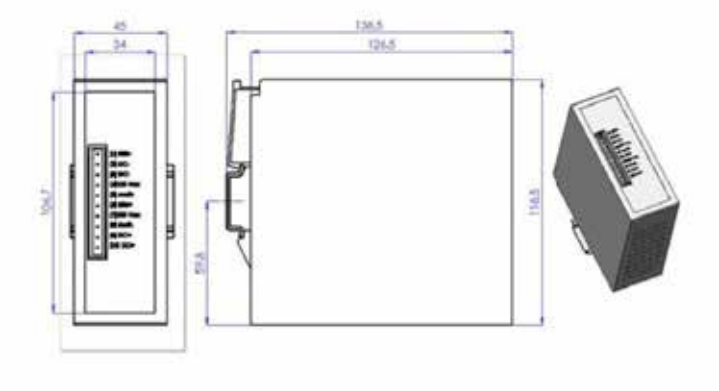
- » Single phase supply 190 - 264 Vac
- » Nominal Output Voltage 340 Vdc (Vout_nom)
- » Nominal Output Power up to 1kW (P_nom)
- » Nominal Braking Power up to 1kW
- » Peak output power up to 4kW (P_pk)
- » Brake Treshold with hysteresis 375 V (V_brake)
- » Nominal External Resistor 70 ohm (minimum 60 ohm)
- » 2 Integrated diagnostic led :
  green > Power/precharge OK
  red > Brake section Fault

Figure 14
AC/DC Power Supply and Brake Unit for TW03

10.1.3. Terminal block

Terminal Block P1 I Phoenix cod. MSTB2,5/10-ST-5,08		
	Name	**Description**
1	BRK-	External brake terminal
2	DC-	TW Motor negative power supply
3	DC-	TW Motor negative power supply
4	220Vac	Single phase power supply
5	GND	Ground connection
6	BRK+	External brake terminal
7	220Vac	Single phase power supply
8	GND	Ground connection
9	DC+	TW Motor positive power supply
10	DC+	TW Motor positive power supply

10.1.4. External dimension



10.2 **TW-T** THREE PHASE

10.2.1. Main Features

TW-T Three phase, 400 Vac rated 1 kW power supply with pre-charge cycle and integral brake unit. SMD technology, 3 phase supply operation, 3 phase supply 200-440 Vac, Dynamic braking (external resistor required). Pre-charge capability. Integrated EMC filter. Nominal output voltage, Vin*1.35 volt, max 600 Vdc. Continuous output power 1 kW. Din rail mounted. Free air convection cooling.

10.2.2. Technical performance

	220Vac		400Vac	
Power Supply	**Single-phase**	**Three-phase**	**Single-phase**	**Three-phase**
Nominal Output Voltage	310 Vdc		565 Vdc	
Nominal Output Power	500 W	700 W	800 W	1200 W
Peak Output Power	2 kW	2,8 kW	3,2 kW	4,8 kW
Clamping Voltage value	375V		750V	
Recommended resistor value	470 / 220 W		470 W	
Braking Nominal Power	300 / 500 W		1 kW	
Auxiliary Power Supply	10 / 30 V, 0,2 A			
System Ready Output	free contact relay 3A Max			
Max. Working Temperature	40 °C			

Note
The supplied external resistor can absorb continuosly a maximum power rating of 100 Watts during braking.

10.2.3. External dimensions

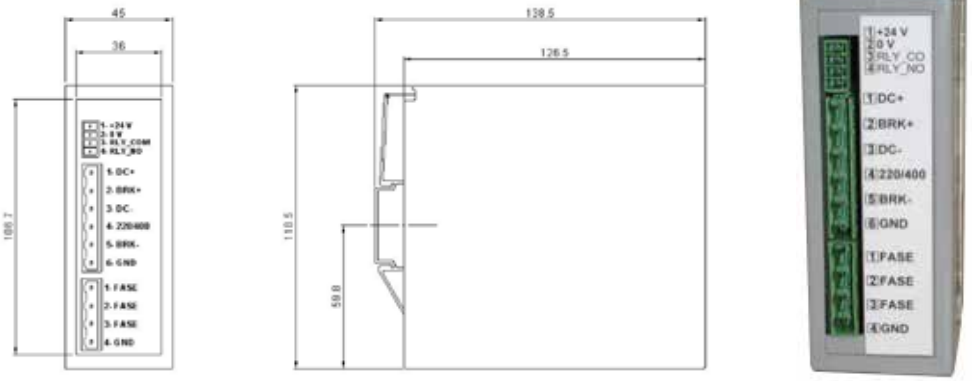
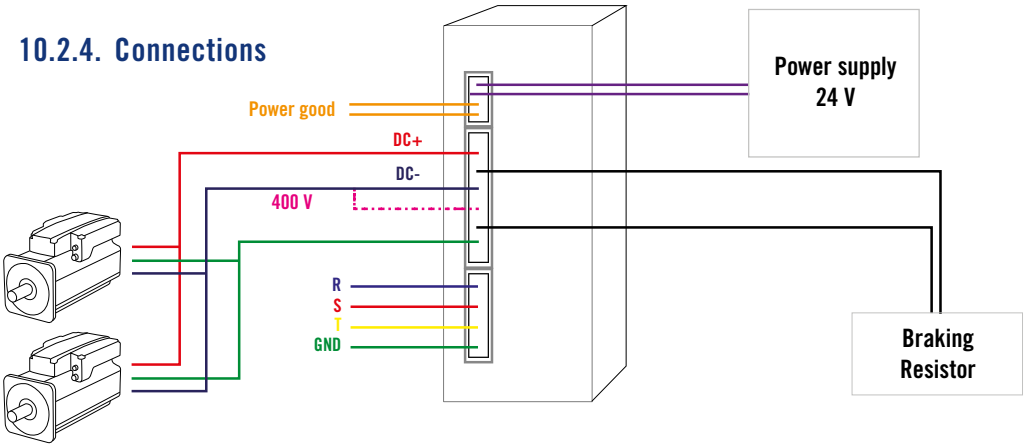


Figure 15
AC/DC Power Supply and Brake Unit for TW03

10.2.4. Connections



10.2.5. Terminal Blocks

CN1		
Pin	Name	Description
1	+24 V	Auxiliary power supply Input positive
2	0 V	Auxiliary power supply Input negative
3	RLY_CO	Common relay contact
4	RLY_NO	Normally closed (NO) relay contact (*)

CN2		
Pin	Name	Description
1	DC +	TW power positive supply
2	BRK +	External brake resistor connection
3	DC –	TW power negative supply
4	220 / 400	Power supply voltage selection (**)
5	BRK -	External brake resistor connection
6	GND	Ground connection

CN3		
Pin	Name	Description
1	Phase input (R)	Three phase input
2	Phase input (S)	Three phase input
3	Phase input (T)	Three phase input
4	GND	Ground connection

(*) This contact is **Closed** during the normal use. It become **Open** in case of an alarm of the Power supply.
(**) Connect to DC- (pin3) in case of 400Vac power supply.

Note:
In case of single phase power supply connect the inputs to two of the three inputs 1, 2, 3 of CN3.

10.3 CAN-USB COMPACT IXXAT INTERFACE

The USB-to-CAN compact is a low-cost, active CAN interface for connection to the USB bus. The 16-bit microcontroller system enables reliable, loss-free transmission and reception of messages in CAN networks with both a high transmission rate and a high bus load. In addition, messages are provided with a time-stamp and can be filtered and buffered directly in the USB-to-CAN compact. The module can also be used as a master assembly, e.g. for CANopen systems. Together with the universal CAN driver VCI, supplied with the delivery, the USB-to-CAN compact allows the simple integration of PC-supported applications into CAN systems.

11

TW MOTORS **PERMISSIBLE SHAFT LOAD**

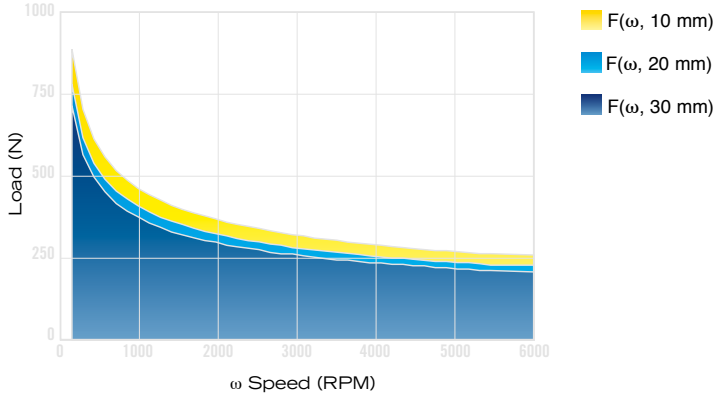
Phase Motion Control
TW Motors with Integrated Servodrive

TW motors employ a classic dual bearing arrangement with axial preload for zero backlash, The bearings are heavy duty type, shielded and lubricated for life. The standard shaft lip seal is available from the motor front for easy replacement or suppression.
All TW motors have a bearing system which is virtually backlash free, locked in the motor frame, and able to support radial, axial and momentum loads. The permissible radial loads vs. point of load application on the shaft are defined in the graphs below for a life expectancy of 30,000 h.

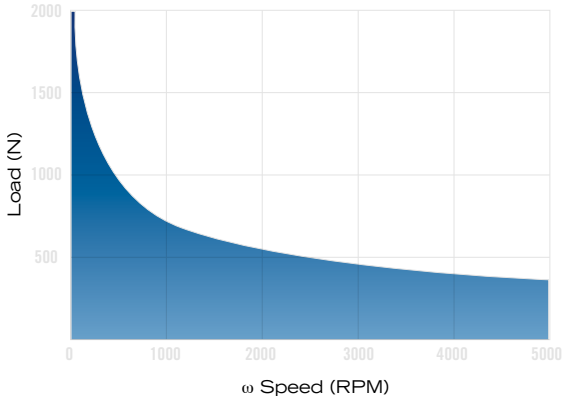
Axial loads should never exceed 30% of radial load. Avoid impacts on the shaft during assembly (hammering) as this would degenerate bearing life. A threaded axial hole is provided to fasten keyless locking assemblies (recommended).
Flange concentricity and perpendicularity are in conformity to IEC 72, Grade R (Reduced tolerance).

Figure 16
TW motors permissible shaft load

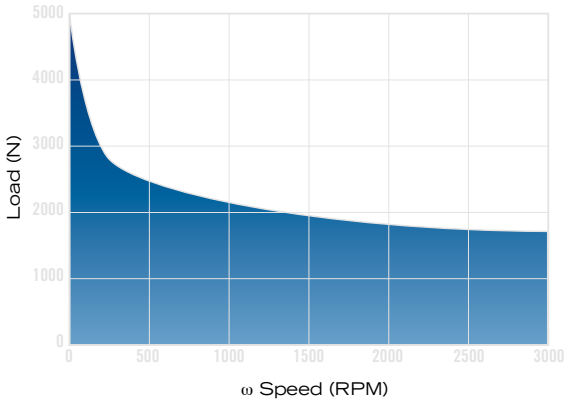
TW03A



TW05A



TW07



12

SAFETY INSTRUCTIONS

Phase Motion Control
TW Motors with Integrated Servodrive

12.1 **IMPORTANT** DIRECTIONS FOR USE

Appropriate Use

Introduction
PMC products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.
The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: PMC as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using PMC products, make sure that all the pre-requisites for an appropriate use of the products are satisfied:

» Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
» If the products take the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
» Do not mount damaged or faulty products or use them in operation.
» Make sure that the products have been installed in the manner described in the relevant documentation.

Areas of Use and Application

Drive controllers made by PMC are designed to control electrical motors and monitor their operation. Control and monitoring of the motors may require additional sensors and actors.

Note: The drive controllers may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or connected. The same applies to cables and lines. Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified.

Every drive controller has to be programmed before commissioning, making it possible for the motor to execute the specific functions of an application. The drive controllers have been developed for use in single- and multiaxis drive and control tasks.
To ensure an application-specific use, the drive controllers are available with different drive power and different interfaces.

Typical applications of the drive controllers include:

» handling and mounting systems,
» packaging and food machines,
» printing and paper processing machines and
» machine tools.

The drive controllers may only be operated under the assembly and installation conditions described in this documentation, in the specified position of normal use and under the ambient conditions as described (temperature, degree of protection, humidity, EMC, etc.).

Inappropriate Use

Using the drive controllers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as “inappropriate use”.
Drive controllers must not be used, if

» … they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, under extreme temperature fluctuations or extremely high maximum temperatures.
» Furthermore, the drive controllers must not be used in applications which have not been expressly authorized by PMC.
» Please carefully follow the specifications outlined in the general Safety Instructions!

12.2 SAFETY INSTRUCTIONS FOR ELECTRIC DRIVES AND CONTROLS

General Information

Using the Safety Instructions and Passing them on to Others
Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible PMC sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.
If the device is resold, rented and/or passed on to others in any other form, then these safety instructions must be delivered with the device.

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

Instructions for Use
Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

» PMC is not liable for damages resulting from failure to observe the warnings provided in this documentation.
» Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
» Proper and correct transport, storage, assembly and installation as well as care in opera-

tion and maintenance are prerequisites for optimal and safe operation of this device.

» Only assign trained and qualified persons to work with electrical installations:
  Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
» Only use spare parts and accessories approved by the manufacturer.
» Follow all safety regulations and requirements for the specific application as practiced in the country of use.

» The devices have been designed for installation in industrial machinery.
» The ambient conditions given in the product documentation must be observed.
» Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and material damage.
» The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
  The machine and installation manufacturer must make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components, make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
» Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.
» Operation is only permitted if the national EMC regulations for the application are met.
» The instructions for installation in accordance with EMC requirements can be found in the documentation “EMC in Drive and Control Systems”.
» The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.
» Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:

Warning symbol with signal word	Degree of hazard seriousness according to ANSI Z 535
DANGER	Death or severe bodily harm will occur.
WARNING	Death or severe bodily harm may occur.
CAUTION	Bodily harm or material damage may occur.

Hazards by Improper Use

	High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!
	Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!
	High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!
	Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!
	Hot surfaces on device housing! Danger of injury! Danger of burns!
	Electrical hazard due to water leakage on electrical component. Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting, or improper handling of pressurized lines!

12.3 INSTRUCTIONS WITH REGARD TO SPECIFIC DANGERS

Protection Against Contact with Electrical Parts

Note: This section only concerns devices and drive components with voltages of more than 50 Volt.

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

High electrical voltage! Danger to life, electric shock and severe bodily injury!

» Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
» Follow general construction and safety regulations when working on electrical power installations.
» Before switching on the device, the equipment grounding conductor must have been nondetachably connected to all electrical equipment in accordance with the connection diagram.
» Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
» Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard

to prevent reconnection.

» With electrical drive and filter components, observe the following:
  Wait 30 minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
» Never touch the electrical connection points of a component while power is turned on.
» Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
» A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.
» Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.

With electrical drive and filter components, observe the following:

High housing voltage and large leakage current! Risk of death or bodily injury by electric shock!

» Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
» The equipment grounding conductor of the electrical equipment and the units must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
» Over the total length, use copper wire of a cross section of a minimum of 10 mm2 for this equipment grounding connection!
» Before start-up, also in trial runs, always attach the equipment grounding conductor or connect with the ground wire. Otherwise, high voltages may occur at the housing causing electric shock

Protection Against Electric Shock by Protective Low Voltage (PELV)

All connections and terminals with voltages between 5 and 50 Volt at PMC products are protective extra-low voltage systems which are provided with touch guard according to the product standards.

High electric voltage by incorrect connection! Risk of death or bodily injury by electric shock!

» To all connections and terminals with voltages between 0 and 50 Volt, only devices, electrical components, and conductors may be connected which are equipped with a PELV (Protective Extra-Low Voltage) system.
» Connect only voltages and circuits which are safely isolated from dangerous voltages. Safe isolation is achieved for example by isolating transformers, safe optocouplers or battery operation without mains connection.

Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

» improper or wrong wiring of cable connections
» incorrect operation of the equipment components
» wrong input of parameters before operation
» malfunction of sensors, encoders and monitoring devices
» defective components
» software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation. The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

» For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

» Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
  use safety fences
  use safety guards
  use protective coverings
  install light curtains or light barriers
» Fences and coverings must be strong enough to resist maximum possible momentum.
» Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don't operate the device if the emergency stop is not working.
» Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.
» Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.
» Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example:
  mechanically securing the vertical axes,
  adding an external braking/ arrester/ clamping mechanism or
  ensuring sufficient equilibration of the vertical axes.
  The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!
» Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
  maintenance and repair work
  cleaning of equipment
  long periods of discontinued equipment use
» Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the

system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

» Persons with heart pacemakers and metal implants are not permitted to enter following areas:
  Areas in which electrical equipment and parts are mounted, being operated or commissioned.
  Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.
» If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.
» Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

Protection Against Contact with Hot Parts

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

» Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
» Do not touch housing surfaces of motors! Danger of burns!
» According to operating conditions, temperatures can be higher than 60 °C, 140 °F during or after operation.
» Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require up to 140 minutes! Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.
» After switching drive controllers or chokes off, wait 15 minutes to allow them to cool down before touching them.
» Wear safety gloves or do not work at hot surfaces.
» For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.

Protection During Handling and Mounting

In unfavorable conditions, handling and assembling certain parts and components in an improper way can cause injuries.

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!

» Observe the general construction and safety regulations on handling and assembly.
» Use suitable devices for assembly and transport.
» Avoid jamming and bruising by appropriate measures.
» Always use suitable tools. Use special tools if specified.
» Use lifting equipment and tools in the correct manner.
» If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
» Do not stand under hanging loads.
» Immediately clean up any spilled liquids because of the danger of skidding.

APPENDIX

Phase Motion Control
TW Motors with Integrated Servodrive

A SERVICE AND SUPPORT

Our service helpdesk at our headquarters in Genoa, Italy and our worldwide service will assist you with all kinds of enquiries.

Helpdesk Support Worldwide
Phone +39 010.835.161 Genoa - Italy
please contact our sales/service office in your area first.

For Support number refers to the sales office addresses on the Internet.
Fax +39 010.42067.33
e-mail: sales@phase.eu, support@phase.eu

Internet
http://www.phase.eu
You will also find additional notes regarding service, maintenance (e.g. delivery addresses) and training.

Preparing Information.

For quick and efficient help please have the following information ready:

» Detailed description of the fault and the circumstances
» Information on the type plate of the affected products, especially type codes and serial numbers
» Your phone, fax numbers so we can contact you in case of questions.

Figure 17
TW03 Motor
TUV Compliance with IEC EN 61800-5-2

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

TÜV SÜD Italia

COMPLIANCE

with IEC EN 61800-5-2

Certificate No.: C-IS-233488-01

CERTIFICATE OWNER: **PHASE MOTION CONTROL S.p.A.**
Via G. Adamoli, 461
I-16141 Genova (GE) - Italy

WE HEREWITH CONFIRM THAT

TW3 MOTORS WITH INTEGRATED SERVODRIVE

MEET THE SIL3 REQUIREMENTS

FOR THE SAFETY FUNCTION: ***Safe torque off (STO)***

Examination result:	**The below described report was found to meet the standard defined requirements of the safety level according to IEC EN 61800-5-2, under fulfillment of the conditions listed in the Safety Manual and reported in the Report R-IS-233488-01-Rev.1 dated June, the 25th 2013 in its currently valid version, on which this Certificate is based**
Examination parameters:	**Functional safety requirements included in the IEC EN 61800-5-2:2007**
Official Report No.:	**R-IS-233488-01 Rev. 1**
Expiry Date	**June, 24th 2014**

IT IS TO BE INTENDED THAT THE ABOVE OFFICIAL REPORT AND ITS ANNEXES ARE AN INTEGRAL PART OF THIS DOCUMENT

Reference Standard **IEC EN 61800-5-2:2007**

Sesto San Giovanni, June, 25th 2013

TÜV ITALIA Srl Industrie Service — TÜV SÜD Italia

TÜV ITALIA Srl
Industry Service Division
Director
Gennaro Oliva

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